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ABSTRACT

Presented is a study which investigated the relationship of mathematics anxiety to mathematics attitudes and mathematics achievement for 62 high math-anxious female college freshmen. Subjects were given the Fennema-Sherman Mathematics Attitude Inventory, including a mathematics anxiety scale, and a mathematics achievement test. High math-anxious subjects were identified from the group of 344 female college freshmen and subdivided into high (34), very high (15), and extremely high (13) subgroups. The results of the study indicate that what high math-anxious college freshmen women appear to have in common is the absence of mathematics attitudes or mathematics achievement that one would logically associate with mathematics anxiety. The implications are that a single treatment method for high math-anxious individuals may not be feasible and that further research is needed to identify the predictors of mathematics anxiety. (Author)

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HIGH MATH-ANXIOUS FEMALE COLLEGE FRESHMEN: WHAT DO THEY HAVE IN COMMON?

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Abstract

The present study investigated the relationship of math anxiety to mathematics attitudes and mathematics achievement for 62 high math-anxious female college freshmen. Subjects were given the Fennema-Sherman Mathematics Attitudes Inventory, including a math anxiety scale, and a mathematics achievement test. High math-anxious subjects were identified from the group of 344 female college freshmen and subdivided into high (34), very high (15), and extremely high (13) subgroups. The results of the study indicate that what high math-anxious college freshmen women appear to have in common is the absence of mathematics attitudes or mathematics achievement that one would logically associate with math anxiety. The implications are that a single treatment method for high math-anxious individuals may not be feasible and that further research is needed to identify the predictors of math anxiety.

Paper presented at the Eighty-ninth Annual Convention of the American Psychological Association, Los Angeles, August, 1981.

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HIGH MATH-ANXIOUS FEMALE COLLEGE FRESHMEN: WHAT DO THEY HAVE IN COMMON?

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Women take significantly fewer math courses than their male counterparts in both high school and college. This may be one reason for the under-representation of women in scientific and technical occupations (U.S. Dept. of Labor, 1975; Wilburn, 1974). In a study of entering freshmen at the University of California-Berkeley, Sells (1973) found that 92% of the women, as opposed to 57% of the men, lacked the high school math prerequisites necessary for 15 of the 20 major fields of study at Berkeley.

Why do women take fewer high school math courses than men? Some psychologists and mathematics educators explain this fact by pointing to a phenomenon labelled math anxiety. Richardson and Suinn (1972) define math anxiety as "feelings of tension and anxiety that interfere with manipulation of numbers and the solving of mathematical problems in a wide variety of ordinary life and academic situations." Tobias (1976) believes that math anxiety is rooted in "... a culture that makes mathematic ability a masculine attribute, that punishes women for doing well in mathematics, and that soothes the slower mathematics learner by telling her she does not have a 'mathematic mind.'" Studies indicate that women, more than men, suffer from the effects of math anxiety (Betz, 1978).

Betz (1978) and Austin-Martin, Waddell, and Kincaid (1980) examined the relationship between educational and psychological factors and math anxiety

in college women. They found that math anxiety has an adverse impact on math achievement and attitudes toward mathematics; that the number of high school math courses was negatively correlated with math anxiety; and, more specifically, that the perceived attitudes toward mathematics of teachers and parents were significantly and positively correlated with subjects' math anxiety.

In a second research study, Kincaid and Austin-Martin (1981) examined the characteristics of and differences between high and low math-anxious female college freshmen. They found significant differences between the two groups on certain specific measures of attitudes toward mathematics. In view of these differences between high and low math-anxious subjects, the question arises as to whether there are differences within each of these two groups.

In the present study, the high math-anxious subjects are further examined in an effort to determine whether their attitudes toward mathematics are homogeneous. If high math-anxious subjects share similar attitudes toward mathematics, then a particular counseling approach is likely to be successful in eliminating their anxiety. However, if it is found that high math-anxious subjects are not homogeneous in their view of mathematics, then different counseling approaches will be needed. In other words, different counseling methods may be required depending on the level of math anxiety prevalent in the student.

The present study investigated the relationship of math anxiety to mathematics attitudes and mathematics achievement for high math-anxious female college freshmen. More specifically, we have examined: a) the characteristics of high, very high, and extremely high math-anxious subjects; b) the relationship between math anxiety, mathematics attitudes, and the total number of high school math courses for high, very high, and extremely high math-anxious subjects; c) the differences among high, very high, and extremely high math-anxious subjects

on attitudes toward mathematics; d) the differences among high, very high, and extremely high math-anxious subjects on mathematics achievement; and e) the differences among the three groups on total number of high school math courses.

METHOD

Subjects

The subjects for the study consisted of female college freshmen enrolled at a small, private, women's liberal arts college in the Midwest. Group 1 (G1) consisted of the entire freshman class of 344 subjects. Group 2 (G2) consisted of 62 high math-anxious subjects who were a subgroup of G1. The subjects in G2 were further subdivided into 3 groups by level of math anxiety as measured by the Fennema-Sherman Math Anxiety Scale. Group 3 (G3) consisted of 34 high math-anxious subjects. Fifteen very high math-anxious students comprised Group 4 (G4) while the 13 extremely high math-anxious students comprised Group 5 (G5). Groups 3 through 5 were subgroups of Group 2. The criteria for determining these 3 subgroups is described in the procedure portion of this paper.

Instrumentation

Mathematics achievement was measured using a 50-item multiple choice test constructed by faculty members in the Mathematics Department at the college. The test had a computed reliability of 0.93. For a group of 130 eighth grade students of average mathematic ability, the mean score was 38. Attitudes toward mathematics were measured using seven scales developed by Fennema and Sherman (1976). Low scores indicate positive attitudes toward mathematics and low math anxiety, while high scores indicate negative attitudes toward mathematics and high math anxiety.

Procedure

The instruments were administered to 344 female college freshmen (G1) in a group situation. All subjects were allowed unlimited time to complete the battery of tests. Subjects who scored one standard deviation above the mean on the math anxiety scale were classified as high math-anxious (G2). This group of 62 subjects was then subdivided into high (G3), very high (G4), and extremely high (G5) subgroups. The categories were determined by dividing the range of scores for the high math-anxious subjects into 3 subgroups as follows: high math-anxious = 45-49; very high math-anxious = 50-54; and extremely high math-anxious = 55-60.

The data were analyzed using an SPSS Program (Nie, et al, 1970) for Pearson product-moment correlation and analysis of variance.

RESULTS

In Table 1, the means, ranges, and standard deviations of scores on the Math Anxiety Scale for groups G1 through G5 are reported. Means, ranges, and standard deviations of scores on the mathematics attitude scales, mathematics achievement, and total number of high school math courses are presented in Tables 2 and 3. Pearson product-moment correlation coefficients for the relationship between math anxiety and mathematics attitudes, mathematics achievement, and total number of high school math courses for Groups G1 through G5 are reported in Table 4. While the high math-anxious groups generally had higher mean scores on the mathematics attitudes scales, perhaps reflecting less positive attitudes toward mathematics, they had lower mean scores on the Math as a Male Domain and Attitude toward Success Scales. The high math-anxious group had a lower mean score on mathematics achievement than the total group

(G1) and completed fewer high school math courses than the total group. For Groups G3 through G5, as math anxiety increased, mean scores on the Math as a Male Domain, Attitude toward Success, and Fathers' Scales decreased, perhaps reflecting more positive attitudes in these three areas. Group G4 showed the highest mean score on mathematics achievement while Group G3 completed slightly more high school math courses than either Group G4 or G5.

In examining correlation coefficients, it was found that Group G2 differed from the total sample (G1) in three areas - mothers' perceived attitude, teachers' perceived attitude, and total number of high school math courses with Group G2 showing no significant correlations in these areas. For Groups G3 through G5, only two significant correlations were found: Group G3 showed a significant correlation between math anxiety and Confidence in Learning Mathematics ($r = 0.3373$, $p < .05$) while Group G5 showed a significant negative correlation between math anxiety and Usefulness of Mathematics ($r = -0.4776$, $p < .05$). All other correlations were nonsignificant for Groups G3 through G5.

In Tables 5-8, analyses of variance of scores on the Confidence in Learning Mathematics Scale, Math as a Male Domain Scale, Usefulness of Mathematics Scale, and the Attitude toward Success in Mathematics Scale for Groups G3 through G5 are reported. These results indicate that Groups G3 through G5 differed significantly in three attitude areas - Confidence in Learning Mathematics, Math as a Male Domain, and Attitude toward Success. On the Confidence in Learning Mathematics Scale, Groups G3 and G4 differed significantly from Group G5 with G5 reporting less confidence in their ability to learn math. On the Math as a Male Domain Scale, Groups G3 and G4 differed significantly from Group G5 with G5 holding a view of math as less of a male domain than the other 2 groups. On the Attitude toward Success in Mathematics Scale, Groups G3 and G5 differed significantly from each other with G5 valuing

success in math more than G3. In their view of the Usefulness of Mathematics, the overall F-ratio (2.64, df = 61, $p > .05$) was not significant for Groups G3 through G5. However, Duncan's New Multiple Range Test showed significant differences between Groups G3 and G4 on the Usefulness of Mathematics Scale, with G4 reporting a more positive attitude toward the usefulness of math.

No significant differences among Groups G3 through G5 were found on mathematics achievement ($F = 1.78$, df = 61, $p > .05$). Furthermore, these three groups (G3, G4, G5) did not differ significantly on the total number of high school math courses completed ($F = 0.59$, df = 61, $p > .05$).

DISCUSSION

The results of the study indicate that there is no clear relationship between math anxiety and attitudes toward mathematics for high math-anxious female college freshmen. Neither is there a clear relationship between math anxiety and mathematics achievement or between math anxiety and total number of high school math courses taken for this group. Thus, what high math-anxious college freshmen women appear to have in common is the absence of mathematics attitudes or mathematics achievement that one would logically associate with math anxiety. Several possible explanations are offered for this finding. First, as we suggested previously (Austin-Martin, Waddell and Kincaid, 1980; Kincaid and Austin-Martin, 1981), math anxiety may be irrational and therefore unaltered by other attitudes toward mathematics or by mathematics achievement. Secondly, math anxiety may be a phenomenon that is more influenced by what one perceives to be appropriate sex role behavior rather than by mathematics achievement or course work in math. Although our research does not reveal a cause and effect relationship between math anxiety and the other

variables examined, it does appear that the search for a predictor of math anxiety will need to proceed in other directions, either adding additional measures to what we have used or looking at other, perhaps behavioral measures, under controlled laboratory conditions. Thirdly, math anxiety appears to be a construct that is not easily definable and that varies sufficiently with each individual that a set of common characteristics of high math-anxious college freshmen women does not exist.

When we examined the differences in high, very high, and extremely high math-anxious female college freshmen, we found some significant differences among them on attitudes toward mathematics. As we anticipated, the extremely high math-anxious group had less confidence in their ability to learn mathematics than the other two groups although they valued success in mathematics more than the high or very high math-anxious subjects. It may be that valuing success in mathematics increases one's math anxiety especially if it runs counter to what one perceives to be acceptable sex role behavior. The relationship between high math anxiety, the attitude toward success in math, and perceived sex role is an area for further research. The finding that extremely high math-anxious subjects viewed math as less of a male domain than the other two groups was unexpected and not easily explainable. It is possible that the Math as a Male Domain Scale is not measuring what one would think or, that math anxiety is part of a generalized anxiety that some highly math-anxious individuals experience in relation to learning, regardless of the subject matter. Further research efforts will need to be made to distinguish between math anxiety and generalized anxiety for this and other populations. The other unclear and unexplainable finding was the fact that very high math-anxious subjects saw math as more useful than did the high or extremely high subgroups.

Another major finding from our study was the absence of differences among

the high math-anxious subgroups on mathematics achievement or total number of high school math courses completed. What high math-anxious female college freshmen appear to have in common is a mathematics achievement level which is slightly below the eighth grade and less than three mathematics courses taken in high school. What remains unknown is whether their math anxiety began early enough to result in poor achievement and little interest in mathematics in high school or whether their poor achievement resulted in high math anxiety.

The results of our research indicate that a single treatment method for high math-anxious individuals may not be feasible. There appears to be enough heterogeneity among high math-anxious subjects that a treatment program for eliminating math anxiety will need to be individualized according to the degree of math anxiety prevalent in the student and the nature of attitudes held toward mathematics.

Table 1

Means, Ranges, and Standard Deviations of Scores on the Math Anxiety Scale for the Total Group (G1), the Total High Math-Anxious Group (G2), and for High (G3), Very High (G4), and Extremely High (G5) Math-Anxious Female College Freshmen

Group	N	$\bar{X}$	SD	Range
Total Group (G1)	344	36.9	8.76	48.0
Total High Math-Anxious Group (G2)	62	50.3	4.50	15.0
High (G3)	34	46.8	1.24	4.0
Very High (G4)	15	52.1	1.55	4.0
Extremely High (G5)	13	57.4	1.45	5.0

Table 2

Means, Ranges, and Standard Deviations of Scores on the Mathematics Attitude Scales, Mathematics Achievement, and Total Number of High School Math Courses for the Total Group of Subjects (G1), and for the Total High Math-Anxious Group (G2)

Variable	Total Group (G1)				Total High Math-Anxious Group (G2)			
	N	$\bar{X}$	SD	R	N	$\bar{X}$	SD	R
Mathematics Attitudes	344				62			
Confidence in Learning Mathematics		35.6	9.16	47.0		44.7	9.80	36.0
Math as a Male Domain		29.3	10.00	44.0		22.5	7.22	27.0
Usefulness of Mathematics		33.1	6.70	37.0		34.2	8.03	32.0
Mothers' Perceived Attitude		34.0	6.40	38.0		34.3	6.30	29.0
Fathers' Perceived Attitude		34.1	7.02	47.0		35.3	7.74	36.0
Teachers' Perceived Attitude		36.1	7.06	43.0		38.6	7.24	33.0
Attitude toward Success in Mathematics		33.2	8.30	42.0		29.8	6.46	30.0
Mathematics Achievement		36.8	8.41	36.0		33.5	7.81	33.0
Total Number of High School Math Courses		3.3	1.48	9.0		2.8	1.18	6.0

Table 3

Means, Ranges, and Standard Deviations of Scores on the Mathematics Attitude Scales, Mathematics Achievement, and Total Number of High School Math Courses for the High (G3), Very High (G4), and Extremely High (G5) Math-Anxious Groups

Variable	High Group (G3)				Very High Group (G4)				Extremely High Group (G5)			
	N	$\bar{X}$	SD	R	N	$\bar{X}$	SD	R	N	$\bar{X}$	SD	R
Mathematics Attitudes	34				15				13			
Confidence in Learning Mathematics		39.9	9.77	31.0		42.4	9.49	34.0		50.3	5.71	22.0
Math as a Male Domain		24.7	6.94	25.0		22.9	7.30	24.0		16.4	3.99	11.0
Usefulness of Mathematics		36.1	7.86	30.0		30.7	8.58	32.0		33.2	6.73	22.0
Mothers' Perceived Attitude		34.5	7.48	29.0		32.4	4.88	17.0		35.8	3.63	14.0
Fathers' Perceived Attitude		37.4	7.45	32.0		33.4	9.06	34.0		32.2	5.42	16.0
Teachers' Perceived Attitude		38.6	6.58	28.0		40.4	8.33	31.0		36.2	7.47	24.0
Attitude toward Success in Mathematics		31.7	5.94	24.0		28.7	6.21	24.0		26.1	6.54	21.0
Mathematics Achievement		32.5	7.72	32.0		36.7	4.27	14.0		32.2	10.36	33.0
Total No. of Math Courses		2.97	1.03	4.0		2.67	1.11	4.0		2.62	1.61	6.0

Table 4

Relationship Between Math Anxiety and Math Attitudes and Math Achievement for Total Group (G1), Total High Math-Anxious Group (G2), High (G3), Very High (G4), and Extremely High (G5) Math-Anxious Female College Freshmen

Variable	Mathematics Anxiety									
	Total Group (G1)		Total High Math-Anxious Group (G2)		High (G3)		Very High (G4)		Extremely High (G5)	
	N	r	N	r	N	r	N	r	N	r
Mathematics Attitudes	344		62		34		15		13	
Confidence in Learning Mathematics		0.3932**		0.4694**		0.3373*		0.3115		0.2572
Math as a Male Domain		0.1041*		-0.3819**		-0.0174		0.1971		0.4489
Usefulness of Mathematics		0.2420**		-0.2215*		0.0152		-0.0722		-0.4776*
Mothers' Perceived Attitude		0.3515**		0.0595		0.1501		-0.1584		0.1076
Fathers' Perceived Attitude		-0.1746**		-0.2911*		0.0108		-0.2224		0.0622
Teachers' Perceived Attitude		-0.3262**		-0.0629		-0.0190		0.1502		0.2148
Attitude toward Success in Mathematics		0.2626**		-0.3930**		-0.0024		-0.3213		-0.4090
Mathematics Achievement		-0.2027		0.0172		-0.1163		0.3609		0.1515
Total No. of Math Courses		0.3158**		-0.0975		-0.0279		0.1516		0.2480

* $p < .05$
** $p < .001$

Table 5

Analysis of Variance of Scores on the Confidence in Learning Mathematics Scale by Subjects' Math Anxiety (High, Very High, Extremely High)

Source of Variation	df	Sum of Squares	Mean Squares	F
Between Groups	2	1029.2	514.6	6.325*
Within Groups	59	4800.6	81.4	
Total	61	5829.8		

*$p < .01$

Table 6

Analysis of Variance of Scores on the Math as a Male Domain Scale by Subjects' Math Anxiety (High, Very High, Extremely High)

Source of Variation	df	Sum of Squares	Mean Square	F
Between Groups	2	649.2	324.6	7.575*
Within Groups	59	2528.2	42.8	
Total	61	3177.4		

*$p < .01$

Table 7

Analysis of Variance of Scores on the Usefulness of Mathematics Scale by Subjects' Math Anxiety (High, Very High, Extremely High)

Source of Variation	df	Sum of Squares	Mean Squares	F
Between Groups	2	323.4	161.7	2.64
Within Groups	59	3612.9	61.2	
Total	61	3936.3		

Table 8

Analysis of Variance of Scores on the Attitude toward Success in Mathematics Scale by Subjects' Math Anxiety (High, Very High, Extremely High)

Source of Variation	df	Sum of Squares	Mean Squares	F
Between Groups	2	326.8	163.4	4.353*
Within Groups	59	2214.9	37.5	
Total	61	2541.7		

*$p < .05$

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